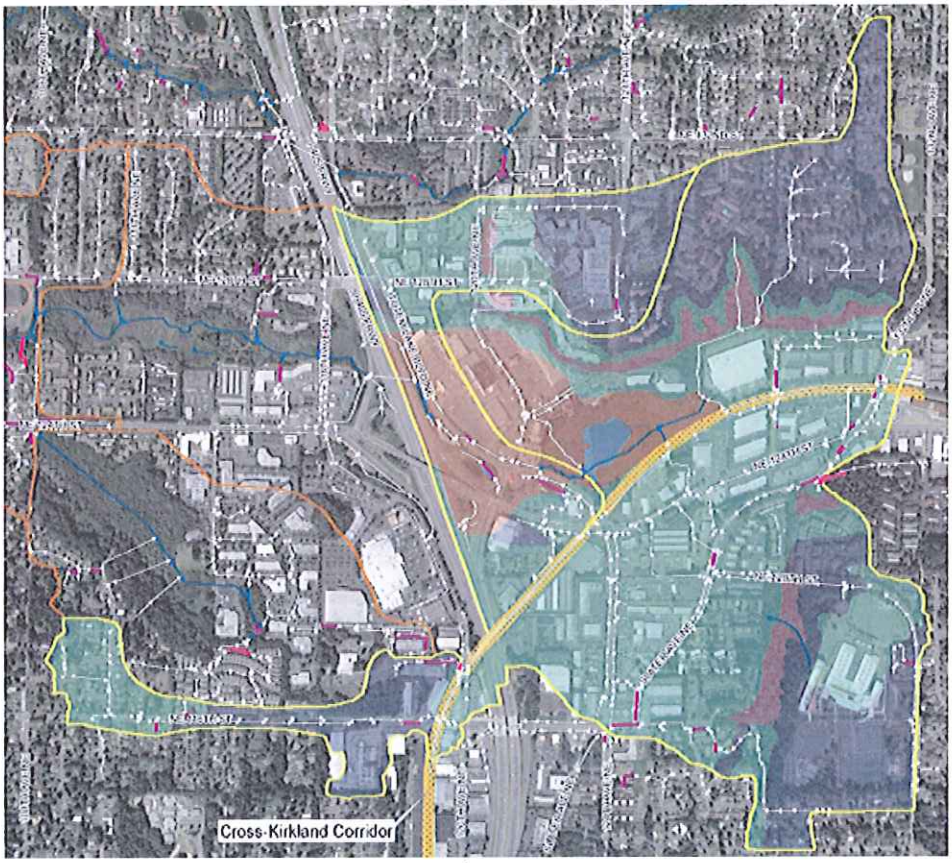
Quality Assurance Project Plan

CITY OF KIRKLAND: TOTEM LAKE/JUANITA CREEK BASIN STORMWATER RETROFIT CONCEPTUAL DESIGN

Ecology Grant Number G1400024



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This project is supported by U.S. Environmental Protection Agency (EPA) National Estuary Program (NEP) funding by means of a grant administered by the Washington Department of Ecology (Ecology). This Quality Assurance Project Plan (QAPP) describes efforts to identify, prioritize, and pre-design specific stormwater retrofit projects in the Totem Lake sub-watershed of the Juanita Creek basin in Kirkland, Washington. The QAPP and final documentation will be available on request from the City of Kirkland and Ecology. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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March 2014

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Introduction and Background

The City of Kirkland (City) was awarded funds by the Washington State Department of Ecology (Ecology) under U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP), Watershed Protection and Restoration program to conduct a Stormwater Retrofit Conceptual Design Study of the Totem Lake/Juanita Creek Basin in Kirkland, Washington. A consultant team led by Northwest Hydraulic Consultants (NHC) was selected by the City to conduct this study. The study will make use of an existing HSPF hydrologic model of Juanita Creek (King County 2012) and a SWMM hydraulic model of the Totem Lake area (Jones & Stokes 2007).

This project will build on previous work completed for the Juanita Creek basin that developed watershed-based ecological goals for stormwater retrofitting and modeled various scenarios against those goals (King County 2012). This project will apply flow control and water quality treatment objectives that meet ecological goals for the Totem Lake sub-watershed and develop prioritized plans and cost estimates for on-the-ground facilities to implement that scenario. This project is a pilot implementation of this ecological goal-based approach to stormwater control in support of watershed restoration.

The 600-acre Totem Lake sub-watershed lies within the Juanita Creek watershed and is one of the most densely developed portions of the Juanita Creek watershed, consisting of both commercial and residential development, as well as major arterial roadways. The Totem Lake sub-watershed was largely developed in the 1970s prior to the widespread implementation of protective stormwater controls. Totem Lake is overwhelmed by high flows, which have caused flooding and contributed to water quality problems that may also impact the greater Juanita Creek watershed. Flooding issues are currently being addressed through capital projects being constructed in 2013 and 2014. Juanita Creek is a 303(d) listed waterbody for fecal coliform, temperature and dissolved oxygen, and Benthic Index of Biotic Integrity (B-IBI) scores are in the poor range downstream of Totem Lake.

The *Stormwater Retrofit Analysis and Recommendations for Juanita Creek Basin in the Lake Washington Watershed* project was completed in 2012 as funded by Ecology Grant G0800618 (King County 2012). That project tested alternative retrofitting scenarios against flow, water quality and biologic integrity goals that are protective of surface water resources and aquatic habitat. The recommendation of that study was to "prepare a detailed plan that includes a time bound implementation strategy and performance targets; and that identifies specific capital projects". The current Totem Lake retrofit project would directly implement that recommendation.

Project Organization

The key individuals responsible for QA/ QC objectives and implementing this project are as follows.

- Tom Gries, Department of Ecology, NEP QA Coordinator. Reviews draft QAPP and report(s). Recommends QAPP approval.
- Bill Kammin, Ecology Quality Assurance Officer. Reviews and approves QAPP.
- Jenny Gaus, P.E., City of Kirkland, Surface Water Engineering Supervisor, Grantee Project Officer. Responsible for overall project management, including review of consultant work products and input on site selection, facility preferences, and implementation plan.
- Patty Dillon, P.E., Prime Consultant, Project Manager and Project Modeling Lead, NHC. Associate hydrologist with NHC responsible for management of consultant tasks and technical lead for modeling and GIS analyses.
- David Hartley, PhD, P.E., Prime Consultant, Principal-in-Charge and Quality Review, NHC. Principal hydrologist with NHC responsible for providing technical leadership and internal quality review for the hydrologic analysis and planning tasks.

Goals and Objectives

This project has multiple levels of objectives that include not only environmental benefits to Totem Lake and Juanita Creek, but also benefits to the region's collective stormwater knowledge and understanding of how flow control standards apply to and within different types of watersheds. The primary objectives of the project are to:

- Assess the applicability of the flow control standard recommended for the Juanita Creek Basin Stormwater Retrofit Analysis report to the Totem Lake sub-watershed.
- Implement a stormwater retrofit plan, including capital project identification, conceptual design and cost estimates for the Totem Lake sub-watershed.
- Implement retrofit projects that provide benefit to Juanita Creek.

Modeling and GIS data analysis will be key tools in the achievement of the overall project goals. The objective of modeling for this project is to help identify the quantity and location of stormwater retrofit projects needed to restore hydrology and water quality in Totem Lake and Juanita Creek watershed. Specific modeling and GIS tasks include:

- Refinement of HSPF modeling of the Totem Lake sub-watershed to provide additional detail.
- Expansion of existing SWMM modeling to include significant drainage paths of the Totem Lake sub-watershed, including many existing stormwater treatment facilities.
- Identification of sites for potential stormwater retrofit projects from GIS data.
- Evaluation of the performance of alternative stormwater retrofit scenarios against water quality and flow control metrics using the HSPF and SWMM models.

Schedule

Table 1 provides a tentative list of completion dates for the tasks included in the Scope of Work.

Table 1. Schedule and Tasks

	GIS/ Modeling Task	2013		2014									
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Task 1: Project Management	NO												
Task 2: Review and Summarize Available Information	GIS												
Task 3: Conduct Gap Analysis	GIS & MODELING												
Task 4: Identify Stormwater Retrofit Locations and Types of Solutions	GIS												
Task 5: Expand Existing SWMM Model and Test Alternatives	GIS & MODELING												
Task 6: Prepare List of Stormwater Retrofit Projects, Conceptual Designs and Cost Estimates	NO												
Task 7: Develop Implementation Plan	MODELING												
Task 8: Knowledge Solicitation and Sharing	NO												

Quality Objectives

EPA's QA/QC guidance (2002) suggests that an appropriate level of quality assurance for model application of this type can be achieved by:

- Use of accepted data gathering methods,
- Use of widely accepted models, and
- Audits and/or data reviews.

The existing HSPF hydrologic model was developed under an Ecology-funded grant and used data gathering methods and data review to meet the first and third requirements. The use of EPA's HSPF and

SWMM models satisfy the second requirement. The quality of the Juanita Creek HSPF model will be maintained throughout the current Totem Lake project. This project will simply refine the HSPF model in the Totem Lake sub-watershed using data sets and techniques consistent with the Juanita Creek project to provide additional detail in the sub-watershed.

Tables 2 and 3 briefly summarize the primary data sets that will be used for the models; please refer to the cited HSPF model documentation for further details. Each data set described was originally collected and checked and controlled for quality by the agency noted.

Table 2. Hydrometeorologic Input Data Sets

Data	Period of Record	Source
Observed and Synthetic 15 min Precipitation	1948-2013	1948 to 1990: NOAA SEATAC precipitation data disaggregated and scaled using local gaged precipitation data 1990 to 2013: King County Juanita Creek (27U) and Norway (51U) precipitation gage data
Observed and Synthetic Puyallup Daily Evaporation	1948-2013	1948-1993: National Weather Service Observed data filled with Jensen-Haise estimates 1994-2013: long term monthly averages
Other Meteorological Data		Will not be used in this study

Table 3. Spatial Data Sets

Data	Date	Source
Surface Geology	2002	King County Surficial Geology
	2010	GeoMap NW for City of Kirkland
Land Use	2002	King County
	2012	City of Kirkland orthophotos
	2013	NAIP orthophotos
Stormwater Infrastructure	2013	City of Kirkland stormwater GIS
	1980-2013	Facility plans and as-builts
Topography	2004-2011	King County / PSLC bare-earth LiDAR
	2014	Ground survey data to be collected by project team

Rainfall and evaporation datasets are used as input to the HSPF model. Spatial GIS data are used to define the surficial geology, topography, land cover, and hydrography, as well as the stormwater infrastructure. The accuracy needed for each of these data sets is dependent on the purpose of the model. For basin planning, where the standard method recommended by Ecology is to perform and compare long-term simulations of the predeveloped, existing, and alternative basins conditions, the same surficial geology, topography, hydrography and hydrometeorologic data are used for all of the

simulations. The surficial geology, topography, and hydrography are dated 2002 or newer, and are consistent with those used in the development of the Juanita Creek HPSF model.

When undertaking comparison studies of this nature, the hydrometeorologic data for basin planning needs to be statistically similar to the actual climate in the basin. In the case of the present study, the hydro-meteorological data available greatly exceed this requirement because of the availability of many years of local precipitation data to compare with and append to long-term NOAA records. The stormwater infrastructure datasets that will be used in the existing conditions and alternatives models are periodically updated by the City of Kirkland.

The Juanita Creek HSPF model was calibrated as part of its original development, and this project will use the calibrated model parameters developed in that study (King County 2012). The calibration data set included stream flow and water quality monitoring from October 2008 to March 2010 throughout the Juanita Creek watershed. Stream flow gaging was performed at six locations and water quality samples were collected at or near the same six locations plus an additional two samples downstream of Totem Lake (King County 2012 Appendix A). The stream flow gaging station on the main stem of Juanita Creek has been operating since 1993 and provided for a longer calibration period.

In addition to the HSPF model, an EPA-SWMM hydraulic model will be extended and refined for this project. The SWMM model will use runoff time series calculated by HSPF model as flow inputs. The SWMM model will not be calibrated, but it will be compared against available anecdotal data of flooding provided by the City of Kirkland. The SWMM model will be extended upstream of Totem Lake using the City's stormwater GIS (referenced above) and ground-surveyed elevations, along with standard literature values for pipe and open channel roughness. The SWMM model will be primarily used to evaluate local flooding and conveyance when comparing the various scenarios for stormwater retrofit and capital improvement alternatives.

Modeling and GIS Activities

As shown in Table 1, only five of the tasks in this project have significant GIS and modeling components. All modeling and GIS activities will be carried out with EPA-approved models, using accepted methods, standard GIS datasets and the appropriate climatic drivers (see previous section) to ensure that the results will be accurate enough for selecting and prioritizing retrofit projects. In general, the approach will be consistent with the Ecology-funded Juanita Creek Retrofit Study (King County 2012) that this project builds on. As presented in the QAPP Waiver Form submitted October 2013, this QAPP specifically addresses the project's plan to complete the following modeling tasks (Tasks 3-5).

In the Gap Analysis Task (Task 3), the existing Juanita Creek HSPF model will be refined to provide additional subbasin definition for the Totem Lake sub-watershed and to add existing flow control facilities, based on plans or as-built data sets provided by the City. The GIS data used to develop the Juanita Creek model will continue to be used for the Totem Lake model refinements, with the exception of more recent detailed geologic mapping that was not available for the prior study. Areas currently served by water quality and/or flow control facilities will be mapped based on the City's data sets. The

refined HSPF model and the City's information of known problem areas will be used to identify subbasins that fall short of performance targets for the basin. Each subbasin will be assessed to determine general types of improvements needed, e.g. water quality, flow control, and/or conveyance.

In the Site Identification task (Task 4), potential stormwater retrofit sites in the Totem Lake sub-watershed will be identified by performing a GIS-based parcel-scale overlay analysis. Concepts and recommendations provided in the Urban Stormwater Retrofit Practices Manual (Center for Watershed Protection 2007) will be used for this screening. Factors to be considered include presence of existing stormwater facilities, property ownership, improvement needs identified in the Gap Analysis, drainage area, proximity to drainage system, soil and groundwater conditions, and topography. The consultant team and the City will collaboratively develop the preliminary screening criteria to create a list of up to 20 potential retrofit sites. Opportunities for stormwater retrofit facilities will be identified for each of the 20 potential sites. The City and the consultant team will work to select up to six retrofit alternatives for numerical analysis.

In the Alternatives Analysis task (Task 5), the six selected alternatives will be evaluated using HSPF and/or SWMM models to compare individual project benefits versus existing conditions. Selected metrics will be compared, e.g. runoff volume, pollutant loading, and Totem Lake inflow hydrology. The SWMM model will be extended upstream of Totem Lake for this alternative analysis. The SWMM network will be expanded to represent conduits 12 inches in diameter and larger in the valley and in the upland residential area in the northeast corner of the basin. The SWMM model will be developed using City of Kirkland GIS drainage system information supplemented by surveyed rim elevations. Conceptual facility size and rough cost estimate will be prepared for each alternative. The City of Kirkland and the consultant team will work to develop weighting criteria to rank the six alternatives with the goal of selection of three projects for conceptual design.

In the Implementation Plan task, the selected capital retrofit projects will be added to the HSPF and SWMM models to determine the combined impact of the retrofits relative to the performance targets and improvements relative to existing conditions. A future conditions scenario will be developed to also consider the impact of the capital alternatives not selected for initial implementation and recommended non-capital programs linked to redevelopment.

Quality Control (QC) Procedures

The modeling and GIS activities will be closely supervised by the project managers. Weekly meetings will be held with the project manager and members of the project team. At these meetings recent and future work will be discussed and reviewed. The City continuously field-verifies their GIS data sets, and for this project ground survey will be collected at select manholes to define accurate elevations for the stormwater network for SWMM modeling. The ground survey and GIS manhole location data will be compared, and additional review may be performed if manhole spatial location is more than three meters different. Additional review will utilize some combination of field verification, as-built drawings, and GIS layers.

Data Quality (Usability) Assessment

The consultant team will provide the City with site recommendations for stormwater facilities using multiple levels of screening. The City will be involved throughout the process of developing and selecting alternatives. The City will review the recommendations and further refinements will be made by the consultant team as necessary. The City will also convene a technical assistance panel (TAP) to review the initial list of retrofit sites. Feedback from the TAP will be considered in narrowing the initial site selections to the alternatives for analysis.

Model Outcome Evaluation

It is difficult to quantify the uncertainty of a hydrologic model. However, HSPF has been the standard watershed model of choice in western Washington for basin-scale modeling since the 1980s. Early basin planning studies in the region that applied HSPF were undertaken by King County (e.g. Coal Creek Basin Plan Technical Appendix, 1986; Bear Creek Current and Future Conditions Report, 1989; Hylebos Creek Current and Future Conditions Report, 1990). Simultaneously in the late 1980s, the US Geological Survey (Dinicola, 1990) developed a set of standard HSPF parameters that characterize the hydrologic behavior of typical impervious surfaces and vegetation-soil complexes that predominate in western Pierce, King, and Snohomish Counties. The ability of HSPF models using these "regional parameters" to directly simulate stream flow hydrographs that match field data (Dinicola, 2001), or to provide an efficient starting point for calibration where data were available, provided a great impetus to further applications of HSPF throughout western Washington by many municipal and county surface water management agencies. Ecology began requiring use of continuous models in its 2001 *Stormwater Management Manual for Western Washington*, and developed the HSPF-based Western Washington Hydrology Model (WWHM) as a standard tool for determining compliance with flow control standards.

EPA-SWMM was first developed in 1971 and in the following decades has become one of the standard models used to evaluate stormwater infrastructure in the United States. It has been widely applied to evaluate stormwater pipe capacity in western Washington. The combination of HSPF hydrology and SWMM hydraulics was used extensively in the 2002 Snohomish County Drainage Needs Reports as well as in more recent nearby projects in Snohomish County, City of Seattle, and City of Redmond for evaluating pipe capacity issues.

Reporting

The project will be documented at several stages using technical memoranda (TM), lists, and maps as shown below. These materials will document GIS and modeling activities carried out during the project. The implementation plan memorandum will provide a final documentation at the conclusion of the project.

- Data Review TM: Data review summary including a list of data needs and an assessment of infiltration and groundwater conditions.
- Gap Analysis TM: Description of performance gaps relative to targets

- Map of areas currently served by stormwater facilities
- Map of up to 20 potential stormwater retrofit sites
- List of stormwater retrofit techniques for each identified potential retrofit location
- Refined ranked list of stormwater retrofit locations (up to 6) including conceptual size and cost
- Alternatives Analysis, Selection, and Conceptual Design TM: Description of the modeling analysis, ranking/selection, and conceptual design of the capital and non-capital alternatives evaluated.
- Implementation Plan TM: Description of the implementation plan for Totem Lake sub-watershed including brief CIP summaries and cost estimates.

The HSPF and SWMM models will be documented in the memoranda listed above. Consistent with standard practice, comments will also be included in the model input files. The models will be provided in an electronic format.

Data Management

During the project, digital data files for modeling and GIS will be stored on NHC servers that are backed up offsite to protect against data loss. The City of Kirkland stores and maintains their GIS data files, project as-built drawings, and digital data archive. Final versions of the HSPF and SWMM model files will be stored on NHC servers during the project. For communication and digital data delivery during the project, data will be uploaded to an NHC-maintained file sharing site that can be accessed by the project team. At the project conclusion, all final modeling, GIS files, and other project deliverables will be provided to the City of Kirkland for their archives.

Conclusions and Recommendations

This project is using HSPF, Ecology's standard hydrologic model for basin planning in Western Washington, and SWMM, the foremost stormwater infrastructure model in the United States. Both models are supported by EPA. The hydrometeorologic and spatial data used to build and calibrate the models are of high quality, from reputable and well-known sources, and have previously been used in the Ecology-funded study of Juanita Creek watershed. The basinwide existing conditions HSPF model was calibrated to local data in the Juanita Creek study and will be used with minimal modification to simulate existing conditions in the Totem Lake sub-watershed. Alternative scenarios will be developed from the existing conditions model, which will lead to valid comparative conclusions regarding the potential effectiveness of each alternative. The SWMM hydraulic model combined with the calibrated HSPF model will provide a reliable tool for assessing hydraulic performance of the stormwater system within the Totem Lake sub-watershed.

References

Center for Watershed Protection. 2007. Urban Subwatershed Restoration Manual No. 3 – Urban Stormwater Retrofit Practices. Version 1.0, July 2007.

Dinicola, R.S. 1990. Characterization and Simulation of Rainfall-Runoff Relations for Headwater Basins in Western King and Snohomish Counties, Washington. U.S. Geological Survey Water-Resources Investigation Report 89-4052. Tacoma, Washington.

Dinicola, R.S. 2001. Validation of a numerical modeling method for simulating rainfall-runoff relations for headwater basins in western King and Snohomish Counties, Washington, U.S. Geological Survey Water-Supply Paper 2495. Reston, Virginia.

Jones & Stokes. 2007. Totem Lake / Juanita Creek EPA-SWMM Model Summary. Memorandum. Prepared by Martin Fisher, submitted to Greg Giraldo, SvR Design Company. December 6, 2007.

King County. 1986. Coal Creek Basin Plan Technical Appendix, King County Department of Natural Resources and Parks. Water and Land Resources Division, Seattle, Washington.

King County. 1989. Bear Creek Basin Current and Future Conditions Analysis, King County Department of Natural Resources and Parks. Water and Land Resources Division, Seattle, Washington.

King County. 1990. Hylebos Creek and Lower Puget Sound Basins Current and Future Conditions Report, King County Department of Natural Resources and Parks. Water and Land Resources Division, Seattle, Washington.

King County. 2012. Stormwater Retrofit Analysis for Juanita Creek Basin in the Lake Washington Watershed. Ecology Grant: G0800618. Prepared By Jeff Burkey, Mark Wilgus, and Hans Berge. King County Department of Natural Resources and Parks. Water and Land Resources Division. Seattle, Washington.

King County. 2012. Appendix A. Water Quality Data Report – Juanita Creek Stormwater Retrofit Project. Ecology Grant: G0800618. Prepared By Eric W. Ferguson. King County Department of Natural Resources and Parks. Water and Land Resources Division. Seattle, Washington.

King County. 2012. Appendix E. Watershed Model Development and Calibration Report for Juanita Creek Stormwater Retrofit Study. Ecology Grant: G0800618. Prepared By Jeff Burkey. King County Department of Natural Resources and Parks. Water and Land Resources Division. Seattle, Washington.

USEPA (U.S. Environmental Protection Agency). 2002. *Guidance for Quality Assurance Project Plans for Modeling (G-5M).* EPA 240-R-02-007. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC.

Washington State Department of Ecology 2001. Stormwater Management Manual for Western Washington, Washington State Department of Ecology Publication No. 99-11, Olympia, Washington.